U. S. DEPARTMENT OF AGRICULTURE
OFFICE OF EXPERIMENT STATIONS

Agricultural Experiment Stations

Their Objects and Work

BY

A. C. TRUE

Director of the Office of Experiment Stations

WASHINGTON
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THE AGRICULTURAL EXPERIMENT STATIONS.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., August 10, 1895.

SIR: I have the honor to transmit herewith for publication as a bulletin of this Office a brief summary of the objects, organization, and work of the agricultural experiment stations in the United States. This publication will in a sense be supplementary to Farmers' Bulletin No 1, The What and Why of Agricultural Experiment Stations, issued soon after the establishment of this Office and now out of print. The complexity of the organization and operations of the stations makes it difficult to clearly present in condensed form even the main features of this great system, but it is hoped that this bulletin will at least enable the reader to correctly interpret the general purpose for which the stations were established and to appreciate in some degree the vastness of the enterprise which the people of this country are maintaining in the effort to utilize the methods and results of scientific inquiry for the benefit of agriculture.

Respectfully,

A. C. TRUE,
Director.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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AGRICULTURAL EXPERIMENT STATIONS.

OBJECTS OF THE STATIONS.

An agricultural experiment station is an institution in which scientific and practical investigations are made with a view to improving the methods of agriculture or introducing new crops or industries. The primary object of an experiment station is to apply scientific principles and methods to the problems of agriculture. It seeks to use for the benefit of agriculture the stores of knowledge regarding the operations of nature which science has accumulated and to employ in the service of agriculture the trained brains and hands of scientists. Taking advantage of whatever has been discovered in any line of scientific research, the experiment station should institute investigations to increase accurate information regarding the great principles which underlie the growth of plants and animals and to make new applications of well-known principles in the practical work of the farmer. It is very important that we should keep clearly before us the conception of the experiment station as primarily a scientific institution. This will enable us to understand its proper functions and prevent us from misjudging much of its work.

The importance of scientific investigations as related to the arts has long been recognized in many industries. Hidden away in almost every factory may be found a chemist, microscopist, or electrician busily engaged in endeavors to solve the problems of the industrial arts. These men are working on the materials used in the arts and have in view practical results, but they are using scientific methods and are employed solely because the manufacturers hope that rich rewards will result from the application of scientific principles to practical ends. The wise employer leaves these men to work in their own way—he does not expect that the chemist will use the blacksmith's bellows, or the grocer's scales, or the carpenter's tools. He must have the apparatus of the chemist and he must be free to follow the methods of the laboratory rather than those of the workshop. The factory chemist may have large wages, he may spoil much valuable material, and he may work for months without any result that will bring a single additional dollar into the manufacturer's treasury, but as long as there is a reasonable hope that something profitable will result the chemist is kept

at his task. One day he may find out something which will give the employer the advantage over his competitors and pay a thousand times over for all the expense which the chemist has caused. There is always the risk of total failure, but experience has shown that in the long run the arts have profited exceedingly by the labors of scientists.

What manufacturers have been doing for themselves because they found it very profitable the Government has undertaken to do for the farmers. Scientific investigations are necessarily expensive. Such investigations as are likely to be of advantage to agriculture must be conducted on so extensive a scale as to be beyond the means of the individual farmer. Agriculture is so fundamental to all other arts and its success is so vital to all classes of people that it has been deemed expedient to extend governmental aid to this industry on considerations of the public welfare.

METHODS OF STATION WORK.

But however it may be supported, the experiment station may be briefly described as an organized effort of science to aid the farmer. The ultimate object in view is the practical result which will benefit agriculture, but the processes by which that result is to be reached will be for the most part such as science shall suggest. To the practical man they will often be obscure and may seem to be absurd. But he must be content if, even after long waiting and much disappointment, he receives benefits which he could not have obtained in any other way. It is necessary to dwell upon this point because it is difficult for many people to understand why the experiment stations insist upon doing so many things which the farmer does not understand, and why even in their simpler work which is along the line of ordinary operations of the farm they depart oftentimes so widely from the traditional practice of successful farmers. It is because the experiment station is not a model farm or a money-making farm or dairy, but an institution in which science is working in the interests of agriculture, that it is bound to use the methods of science rather than those of the practical farmer. There should be order and system in the work of the station—more thorough and rigid than the best farmers enforce—but such methods should be followed as science approves. This should be the case even in the conduct of the field work of the station, which involves the use to a considerable extent of the ordinary operations of the farm. Suppose, for example, an experiment with fertilizers is to be made. The field must be carefully selected, the plats accurately measured, the seeds tested, the fertilizers analyzed and weighed, the soil physically and chemically examined, the growth of the crop closely watched, the product certainly determined and examined—a hundred things must be done which the farmer does not need to do; that is, the object should be to make careful and accurate observations of the materials and phenomena involved in the experiment, and to classify these observations

with a view to determining the real effects of the different fertilizers on the crop.

Work of that kind is scientific though much simpler than is necessary in other lines of station work. Now, it may be that at the end of the experiment some farmer will look over the plats, and, seeing marked differences in the results produced by different fertilizers, will say it is plain enough that this fertilizer is good for this crop in this soil and that fertilizer is of no benefit. In a general way an experienced farmer may estimate the results of the experiment as well as the experiment station officer, and for that reason he may think that all the pains which the station takes to get an accurate record of the experiment is largely a waste of time and money. But whoever thinks thus misses the essential value of experiment station work. Farmers have been going on for generations in certain practical lines, and as the result of the irregular and haphazard efforts of intelligent men have gradually improved the practice of their art. Experience is valuable, and he who tries new ways of work may prove a benefactor; but the glory of our age is that men have begun to introduce system into their schemes for improvement and have found that by careful experimenting in accordance with an orderly plan they can make much more rapid progress and avoid many disheartening failures.

The experiment station has been established to do this work for the farmer, and it is its duty to blaze out new paths and not to follow the beaten track, even though to many it may seem to be a good one. The practice of good farmers is oftentimes a false guide. The station should not follow it unless it can see the reason for it. It must study the matter from the other standpoint, viz, that of the investigator, and make sure that it is right. Let us illustrate this by an example drawn from the feeding of animals. One of the stations was examining the rations which farmers were feeding to their milch cows. It came to one man who was considered by his neighbors a successful feeder, keeping his animals in good condition and making money from their products. On examination his rations proved to be quite different from those recommended by the feeding standards. A year later, when the station officers made a second visit to this farmer, they found that he had made a radical change in his rations, which now conformed quite closely to the standards. Inquiry showed that the feeder had become convinced that, while he was making money before, he could make more by following the advice of the station, which was based on the scientific principles of feeding. In that case, at least, science was a better guide than what seemed to be a successful practice.

Another point to be carefully considered in judging of the work of agricultural experiment stations relates to the nature of the scientific investigations which they may properly undertake, and to the kind of results which may reasonably be expected from such investigations. In the thought of many people the term "science" seems to include only

what are sometimes called the "exact sciences"—that is, sciences based on such principles and dealing with such subjects that when results have been obtained they may be applied in a fixed way to all similar cases in accordance with exact formulas. For example, the method of calculating eclipses has been definitely determined by astronomers so that it is only necessary for one to learn the mathematical formulas and processes in order to determine the time of the occurrence of any eclipse. Obviously such definiteness of results can not be expected in agricultural investigations. There we have to deal with the complex problems of the air, soil, plant, and animal. Thus far science has advanced only a little way in the discovery of the principles governing the manifold intricate operations which are continually going on in the world with which agriculture deals. All that the scientist can do at present is to assure the farmer that his studies have brought to light certain facts and principles which may serve as a guide to the improvement of the methods of agriculture. Further investigations will undoubtedly bring more light on many subjects, but the time will probably never come when definite rules for farming can be formulated either by the scientist or the farmer.

In this respect medicine and agriculture are very much alike. We insist more and more that our doctors shall be trained in scientific knowledge, and we devote much money to scientific investigations which may improve the healing art, but we do not expect that a code of definite rules for the treatment of diseases will ever be devised. In fact, one thing which scientific research makes clearer as it advances is that there exist in every human body certain individual peculiarities which manifest themselves in disease as well as in health, so that the wise doctor must vary his practice according to the patient. It is for this reason that a family physician who for a long time has studied the peculiarities of the different members of a family is as a rule much more likely to succeed in treating the diseases of that family than a stranger, however skillful he may be. In like manner the intelligent farmer is the man who carefully studies his land and his animals, and, while taking advantage of all the teachings of science and experience, shapes his practice according to his own needs. The experiment stations may greatly benefit agriculture, but, in accordance with a law which governs all human progress, they will inevitably help to make farming a more complex occupation. Greater technical knowledge will be required to be a successful farmer in the twentieth century than has hitherto been needful. Every year it becomes more difficult for the ignorant farmer to secure even the necessities of life.

HISTORY OF THE STATIONS.

About one hundred years have elapsed since scientific men began to give attention to the problems of agriculture, but it is less than fifty years since the first regularly organized experiment station was estab-

lished in the little German village of Moeckern. In this country the first station was begun at Wesleyan University, Middletown, Conn., in 1875—just twenty years ago—though similar work had been previously carried on at some of the agricultural colleges. California, North Carolina, and New Jersey were among the first States to organize experiment stations. The early work of the stations attracted so much favorable attention that their number rapidly increased. In 1887 there were seventeen stations in fourteen different States. That year Congress passed what is popularly called the Hatch Act, which gives to each State and Territory $15,000 a year from the National Treasury for the maintenance of an agricultural experiment station which, except in a few cases indicated in the law, must be a department of the college established under the land-grant act of July 2, 1862. It was presumed by Congress that the States would provide land, buildings, and other equipment for the stations, and the law therefore provides that the money shall be chiefly expended in carrying on agricultural investigations and reporting their results.

The work of the stations is thus outlined in the act: "It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals—the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories." Under this law the stations are independent State institutions, each working in its own way under the direction of the local authorities, who alone are responsible for the expenditure of the funds committed to their trust by Congress. During the past year, however, it has been made the duty of the Secretary of Agriculture to ascertain whether station expenditures are made in accordance with the law and to report the results of his inquiries to Congress.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories. Alaska is the only section of the United States which has no experiment station. In each of the States of Alabama, Connecticut, New Jersey, and New York a separate station is maintained wholly or in part by State

funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by sugar planters. In several States substations have been established. Excluding the branch stations, the total number of stations in the United States is fifty-four. Of these fifty-one receive the appropriation provided for in the act of Congress above mentioned.

ORGANIZATION OF THE STATIONS.

The organization of the experiment stations under the law has naturally taken many different forms, and their work has been largely determined by local needs and demands. It is, therefore, difficult to describe what might be called a typical experiment station. Some common features of station organization and work may, however, be briefly mentioned, which it is hoped may at least sufficiently interest the reader to lead him to look more carefully into the actual operations of the stations, especially in his locality.

Since the station is a department of the land-grant college, it is as a rule under the general management of the governing board of that institution. The more immediate supervision of station affairs is often left to a standing committee of the board, which may include also some college and station officers. The president of the college has more or less to do with the management of the station and may even be its director. In many cases, however, the director is a separate officer who, in addition to general executive duties, carries on investigations in some special lines or combines teaching in the college with his work for the station. Thus the station director may be a chemist or an agriculturist and at the same time professor of chemistry or agriculture. In some cases the director has large powers and responsibilities in the management of the station; in other cases the planning of the work is largely committed to a council composed of members of the governing board and station staff. Besides the director, the station staff usually comprises several scientific experts in charge of special lines of work, as dairying, horticulture, chemistry, entomology, or diseases of plants or animals, and scientific assistants, together with persons of practical experience as foremen of farms, dairymen, feeders of cattle, etc.

The region for which each station works is, with few exceptions, so large and the agricultural problems of each community so numerous that urgent calls are made upon the individual stations to undertake work in various lines, and there is a constant temptation to attempt more kinds of investigations than can be successfully carried on with the resources at hand. The wisest of our stations are, however, vigorously struggling against this tendency, and are each year making it clearer that the best way is to do a few things thoroughly and well. The ideal plan is for each station to pursue those special lines of work to which its environment makes it peculiarly adapted. Thus one sta-

tion may be eminent for its work in dairying, another in the feeding of milch cows or sheep, another in horticulture, another in soil investigations, and another in irrigation. Whatever any one station discovers of real and permanent usefulness can easily be disseminated in all the regions of our country to which it is applicable. The experiment station may have its own farm, but more commonly uses for experimental purposes a portion of the farm belonging to the college with which it is connected. As it is not the business of the station to carry on a farm for profit, it will properly work only as much land as is needed for such experiments as can be rigidly planned and carefully supervised and controlled. Here, again, the temptation is to use too much land, to have showy rather than thorough field experiments.

One very important feature of an experiment station farm is its series of permanent plats. The bounds of these plats are very carefully fixed, the chemical and physical properties of the soil are accurately determined from time to time, and a complete record is kept of the fertilizers applied and the crops grown each season. Some work is planned which is to continue for many years on the same land in the hope that as the data accumulate year after year facts of wide interest may be revealed. Perhaps the most notable example of this kind of work is found at Rothamsted, England, where Lawes and Gilbert have observed the growth of wheat and some other crops on the same land in this careful way for over forty years.

BUILDINGS AND EQUIPMENT.

The buildings of the stations include offices, museums, libraries, chemical, botanical, bacteriological and other laboratories, barns, dairy buildings, silos, plant houses, insectaries, and other buildings required for special purposes.

The equipment consists of scientific apparatus of various kinds, much of which will necessarily be elaborate and expensive, and of such farm implements and live stock as are needed for use in the investigations, together with a carefully selected working library and collections of specimens. As one of the very important lines of station work is the improvement of the methods of experimenting, we naturally expect to find in station laboratories and museums pieces of apparatus devised by station officers. When our people understand better than they do now that this kind of experimenting is essential to the most efficient work of our stations we shall expect to find more stations engaged in it, even if they have to give up some of the field work.

WORK OF THE STATIONS.

The work of the agricultural experiment stations as organized in this country may be classified in a general way as follows: (1) They act as bureaus of information on many questions of practical interest to the farmers of their several localities; (2) they seek by practical tests

to devise better methods of agriculture and to introduce new crops and live stock, or to establish new agricultural industries; (3) they aid the farmer in his contest with insects and with diseases of his crops and live stock; (4) they help to defend the farmer against fraud in the sale of fertilizers, seeds, and feeding stuffs; (5) they investigate the operations of nature in the air, water, soil, plants, and animals in order to find out the principles which can be applied to the betterment of the processes and products of agriculture.

The experiment stations are conducting a wide range of scientific research in the laboratory and plant house and an equally large amount of practical experimenting in the field, the orchard, the stable, and the dairy. Thirty stations are studying problems relating to meteorology and climatic conditions. Forty stations are at work upon the soil, investigating its geology, physics, or chemistry, or conducting soil tests with fertilizers or in other ways. Fourteen stations are studying questions relating to irrigation. Thirty-nine stations are making analyses of commercial and homemade fertilizers, or are conducting field experiments with fertilizers. At least fifteen stations either exercise a fertilizer control in their respective States or make analyses on which the control is based. All the stations are studying the more important crops, either with regard to their composition, nutritive value, methods of manuring and cultivation, and the best varieties adapted to individual localities, or with reference to systems of rotation. Thirty-five stations are investigating the composition of feeding stuffs, and in some instances making digestion experiments. Thirty-seven stations are conducting feeding experiments for milk, beef, mutton, or pork, or are studying different methods of feeding. Thirty-two stations are investigating subjects relating to dairying, including the chemistry and bacteria of milk, creaming, butter making, or the construction and management of creameries. Forty-five stations are studying methods of analysis and doing other chemical work. Botanical studies occupy more or less of the attention of about thirty stations; these include investigations in systematic and physiological botany, with especial reference to the diseases of plants, testing of seeds with reference to their vitality and purity, classification of weeds, and methods for their eradication. Forty-three stations work to a greater or less extent in horticulture, testing varieties of vegetables and large and small fruits, and making studies in varietal improvement and synonymy. Several stations have begun operations in forestry. Thirty-one stations investigate injurious insects with a view to their restriction or destruction. Sixteen stations study and treat animal diseases or perform such operations as dehorning animals. At least seven stations are engaged in bee culture, and three in experiments with poultry.

A million dollars are now annually expended in the United States in the maintenance of agricultural experiment stations. Three-quarters of this large sum comes from the National Treasury. While this is a

much larger aggregate expenditure for this purpose than has ever been made by any other nation, it involves the use of only 30 cents for each $1,000 of our agricultural product in an attempt to improve the quality and quantity of that product. From this point of view the resources of the stations can not be deemed unreasonably large, especially when we consider the wide diversification of our agriculture even under present conditions, and the great need for more rational and profitable methods of farming. On the other hand, the annual expenditure of so vast a sum from the National Treasury can not be justified unless the institutions conducted under this grant show a keen appreciation of their responsibility to make a wise and economical use of the funds intrusted to them by the people.

NUMBER OF STATION OFFICERS.

The stations employ 557 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 67; secretaries and treasurers, 26; librarians, 8; clerks, 27; in charge of substations, 40; agriculturists, 55; biologists, 11; botanists, 36; chemists, 124; entomologists, 43; geologists, 5; horticulturists, 61; irrigation engineers, 7; meteorologists, 15; mycologists and bacteriologists, 7; physicists, 3; veterinarians, 24; dairymen, 11; farm foremen, 25.

There are also 28 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds, and buildings, apiarists, herdsmen, etc.

EXTENT OF STATION PUBLICATIONS.

Since their establishment the stations have published several thousand annual reports and bulletins. In 1894 they issued 54 annual reports and 401 bulletins. An average edition of 10,000 copies of each of these publications was distributed in the several States and Territories, or over 4,500,000 copies in the aggregate.

Besides regular reports and bulletins, a number of the stations issue press bulletins, which are widely reproduced in agricultural and county papers. The station bulletins are now regularly distributed to half a million persons who are either farmers or closely identified with the agricultural industry. Moreover, accounts of the station work are given and discussed in thousands of newspapers. The New York Cornell Station alone estimated some time ago that each one of its publications directly or indirectly reached more than half a million readers. Besides this a very large correspondence with farmers is carried on, hundreds of public addresses are annually made by station officers before farmers' meetings, and the results of station work are taught to thousands of students in agricultural colleges.

The requirement of the law by which each station must issue a report and at least four bulletins each year, while it has in many cases caused the premature publication of unfinished experiments, has also greatly stimulated the dissemination of useful, practical information through the stations. The work connected with the preparation, publication, and mailing of the reports and bulletins is very large. The mailing lists of the stations now average about 10,000 addresses each. When we add to the publication work an extensive correspondence and the keeping of accurate official records and accounts it is seen that the burden of clerical duties imposed upon the stations is quite heavy.

WAYS IN WHICH THE STATIONS HELP THE FARMER.

The service which the stations have rendered in promoting the education of our farmers is incalculable.

Even if the station bulletins recorded only facts well known to scientists and advanced agriculturists, the influence of such a far-reaching system of popular education in agriculture must be very great. So vast a scheme of university extension has never been undertaken in any other line.

The stations have also taught the farmer how to help himself. In a number of lines their work has shown that to be thoroughly successful the farmer must himself be an experimenter. This has been notably brought out by the experiments in the use of fertilizers. Hundreds of farmers have already made experiments in cooperation with the stations, and have thus learned something about proper methods of experimenting, and have given their neighbors valuable lessons on the way to apply the experience gained by scientific investigators to the peculiar conditions of individual farms.

But the stations have also found out some things which are new, and have performed services of great economic value.

In the study of soils and fertilizers; in the tests of new varieties of cereals, forage plants, vegetables, and fruits; in researches on the composition and digestibility of feeding stuffs; in feeding experiments, especially with pigs and dairy cattle; in investigations in dairying, especially regarding means for testing milk and the methods of cheese making; in observations on plant diseases and injurious insects, and in experiments on the repression of these foes of the farmer, many useful results have been reached.

In general it may be said that the stations are in better condition than ever before to do efficient service for the improvement of our agriculture. Experience has shown the need and value of experimental inquiries in the lines pursued by the stations, and the economic results have been sufficient to justify the continuance and development of these institutions under such conditions as will enable them to do their most useful work.

The general interests of the stations are promoted by the Association of American Agricultural Colleges and Experiment Stations, a voluntary association organized in 1887, which holds annual meetings in different parts of the country. The proceedings of the association are published by the Office of Experiment Stations of this Department.

THE OFFICE OF EXPERIMENT STATIONS.

The act of Congress establishing the stations makes it the duty of the Secretary of Agriculture to render to them such advice and assistance as may best promote the objects for which they were established. For this purpose an Office of Experiment Stations was organized as a branch of the Department of Agriculture in October, 1888.

Its main business has been the examination of the work of the agricultural experiment stations in this and other countries and the collation and publication of data regarding experimental inquiries in agriculture for the information of station workers, farmers, and others interested in the progress of the science and art of agriculture. There are now some 320 experiment stations in operation in the different countries of the world. Besides the publications which these stations issue, very many reports of agricultural inquiries at these and other institutions are published in current periodicals. As far as practicable this Office seeks to traverse this large mass of literature and to cull from it such information as will enable our station workers to keep posted regarding the progress of agricultural science and will promptly bring to our farmers the practical outcome of these investigations in the different countries.

Up to January 1, 1895, the office had issued 135 documents, including 5 volumes of the Experiment Station Record, 20 bulletins, and 9 Farmers' Bulletins.

The Experiment Station Record is issued in parts, and contains abstracts of the current publications of all the American stations, of the several divisions of the United States Department of Agriculture, and of reports of foreign investigations in agricultural science. General information is also given regarding the stations and kindred institutions in this and other countries, and suggestions regarding methods and lines of investigations which may usefully be followed by our stations are made in articles by the editors and by distinguished experts in the different specialties at home and abroad. A detailed subject and author index is published with each volume. As the condensed form of the Record makes its language necessarily technical, it is distributed chiefly to agricultural college and station officers, libraries, and educational institutions.

The practical results of agricultural investigations at home and abroad are also summarized in this office and published in Farmers' Bulletins, which are widely distributed to farmers. The work of the office in this line will be extended in the future.

Schedules for the financial reports of stations, as now required by Congress, are prepared in this office, and the office also makes an examination of the stations as the basis of the report of the Secretary of Agriculture to Congress regarding the expenditures and work of the stations.

Congress having given this Department an appropriation for investigations on the nutritive value and economy of human food, the supervision of this work has been assigned to this office. Popular and scientific résumés of such investigations in this country and abroad have already been published and inquiries in this line are now in progress in a number of representative localities North and South, largely in cooperation with agricultural colleges and experiment stations.

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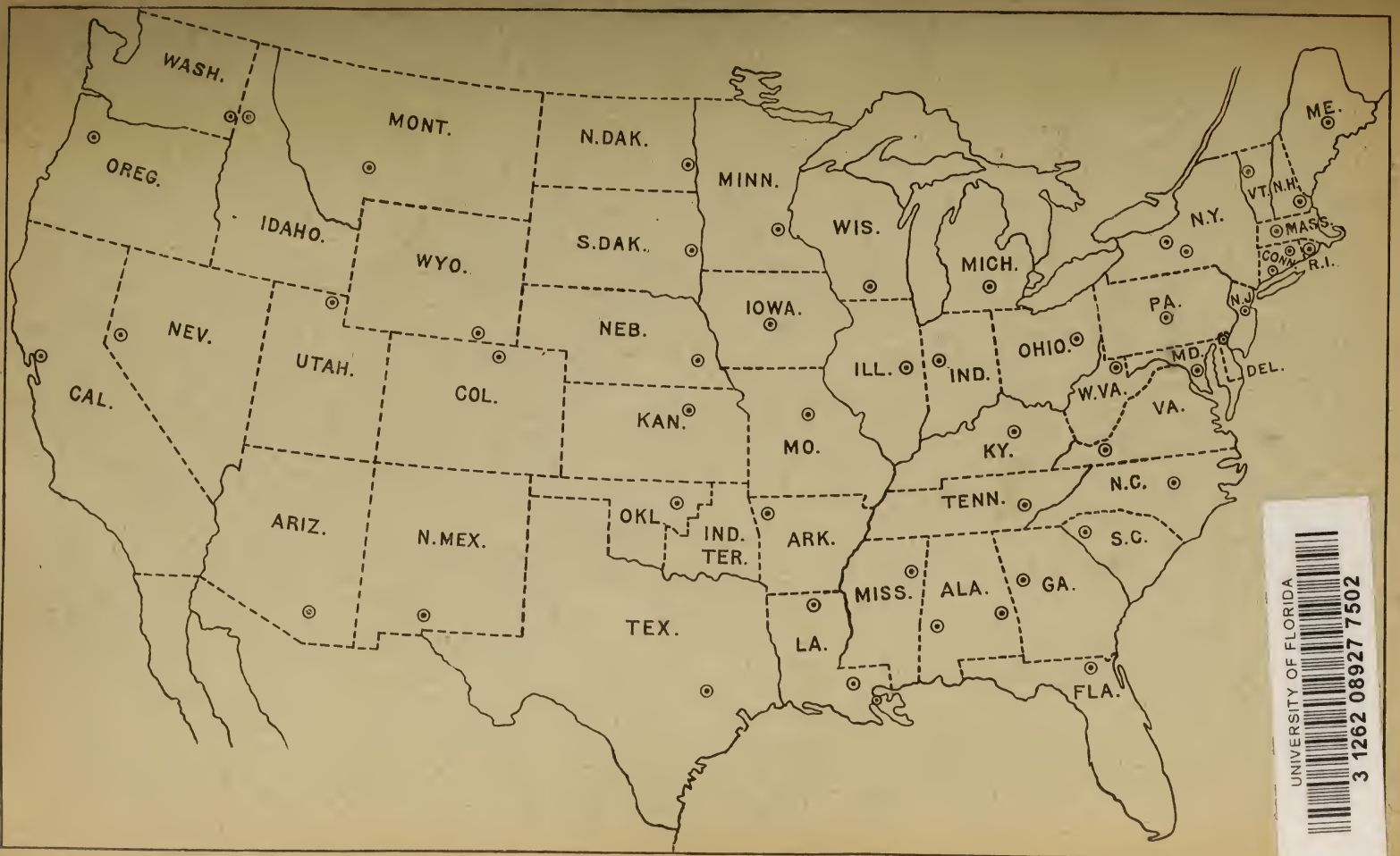

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